

A Review on IoT Based Solid Waste Management System

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Abstract: *The proposed project presents an Automatic Solid Waste Management System using Arduino-based technology to separate waste into wet, dry, and metal categories. The system employs an IR sensor to detect the presence of waste, a moisture sensor to distinguish between wet and dry waste, and a proximity sensor for identifying metal waste. The Arduino UNO acts as the control unit, processing the inputs and controlling a servo motor to direct waste into the appropriate bin. This automated method ensures efficient waste segregation, reduces human effort, promotes recycling, and supports a cleaner environment. The system provides a smart, low-cost, and eco-friendly solution for modern waste management.*

This project can be implemented in public places, colleges, offices, and residential areas to improve cleanliness and reduce manual segregation. By integrating such automated systems, the burden on waste collectors can be minimized and the collected waste can be efficiently processed for recycling and composting, thus contributing to sustainable development. Furthermore, the project enhances public awareness regarding proper waste disposal, encouraging responsible environmental practices. It also demonstrates the potential of IoT and automation to solve real-life challenges. With further improvements and scalability, this system can serve as a reliable model for future smart cities.

Keywords: Automatic Waste Management, Arduino UNO, IR Sensor, Moisture Sensor, Proximity Sensor, Servo Motor

I. INTRODUCTION

In the quickly urbanizing world of today, solid waste management has emerged as one of the most important issues. The amount of garbage produced daily has greatly increased due to changes in lifestyles, industrial growth, and population growth. The increase in trash production has resulted in significant problems with environmental contamination, poor recycling practices, and hygiene. Inadequate waste management and segregation lead to air, water, and soil contamination, which impacts ecological balance and human health. Traditional waste management techniques are not meeting the increasing demand for sustainability and efficiency as cities grow.

The manual sorting of waste, which remains prevalent in numerous regions, is both unsanitary and inconsistent. It necessitates a significant amount of human labor and frequently exposes workers to dangerous materials and infections. Furthermore, human-driven sorting is labour-intensive and susceptible to mistakes, rendering it inadequate for extensive waste processing. This scenario underscores the pressing necessity for automation in waste management systems capable of executing segregation efficiently, safely, and in real-time.

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The proposed initiative, named "IoT-Based Smart Waste Segregation System," aims to tackle these issues through automation and sensor-driven technology. The system autonomously categorizes waste into wet, dry, and metal types utilizing a series of sensors linked to an Arduino UNO microcontroller. This automation removes the requirement for manual sorting, guaranteeing a cleaner, quicker, and more sanitary process. By merging straightforward yet effective hardware components with intelligent programming, the system offers a cost-efficient solution appropriate for both small-scale and large-scale applications, including public spaces, educational institutions, offices, and residential neighbourhoods.

In this system, an Infrared (IR) sensor is employed to detect the presence of waste, while a Moisture sensor determines whether the waste is wet or dry. Additionally, a Proximity sensor is utilized to identify metallic waste. After the sensors gather data, the Arduino UNO processes this information and operates a servo motor that directs the waste into the correct bin. This process ensures precise segregation and reduces human involvement, thereby enhancing hygiene and operational efficiency. The design is straightforward, modular, and cost-effective, making it an ideal solution for developing cities that need low-cost yet intelligent technology for waste management.

Methods such as word embeddings can also be applied to capture semantic relationships between words, further improving model performance.

Table 1: Literature Survey Table

Paper / Project	System Architecture	Cost	Ease of Implementation	Performance	User Experience	Limitations
A. Patil and V. Kulkarni, "Smart waste management system using IoT," (2020) [1]	IoT- Based smart bin with IR and ultrasonic sensor	Moderate	Moderate	Efficient detection and monitoring of waste levels	User- friendly real-time monitoring	Limited scalability for large networks
A. Singh et al., "Smart garbage management system using Arduino and moisture sensor," (2021) [2]	Arduino and sensor integration for wet/dry segregation	Low	Easy	Accurate classification of wet and dry waste	Simple design	Cannot detect metallic waste
P. Kumar and A. Verma, "Image processing based waste classification system," (2018) [3]	Camera with image processing	High	Moderate	Accurate waste identification using image features	Automated classification	High computational cost and lighting dependency
Eco-Sort, "Low-Power Eco-Friendly Smart Bin Using Ultrasonic and Moisture Sensors," (2024) [4]	Arduino-based low-power architecture	Low	Easy	Reliable and power-efficient	Eco-friendly and portable	Limited to small capacity bins
R. Gupta and S. Mehta, "IoT and GSM based smart waste collection system," (2019) [5]	IoT + GSM for data transmission and bin alert	Moderate	Moderate	Efficient communication for waste collection	Real-time alerts for collection	GSM coverage required for operation
K. Reddy et al., "Smart bin using Arduino and IR sensors for automatic waste monitoring," (2020). [6]	IR sensors with Arduino control unit	Low	Easy	Effective waste detection	Simple and low cost system	High setup cost and data training requirement



S. Alam et al., "AI-assisted IoT-enabled waste classification for smart cities," (2022) [7]	Multi-sensor with IoT	Moderate	Moderate	Efficient hybrid classification	Integrate multiple sensors for accuracy	Slight delay in processing
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III. PROPOSED METHODOLOGY

The methodology of the smart waste segregation system is designed to automate the process of detecting, classifying, and separating different types of waste using sensor-based technology and an Arduino microcontroller.

Figure 1 shows block diagram of proposed methodology

BLOCK DIAGRAM

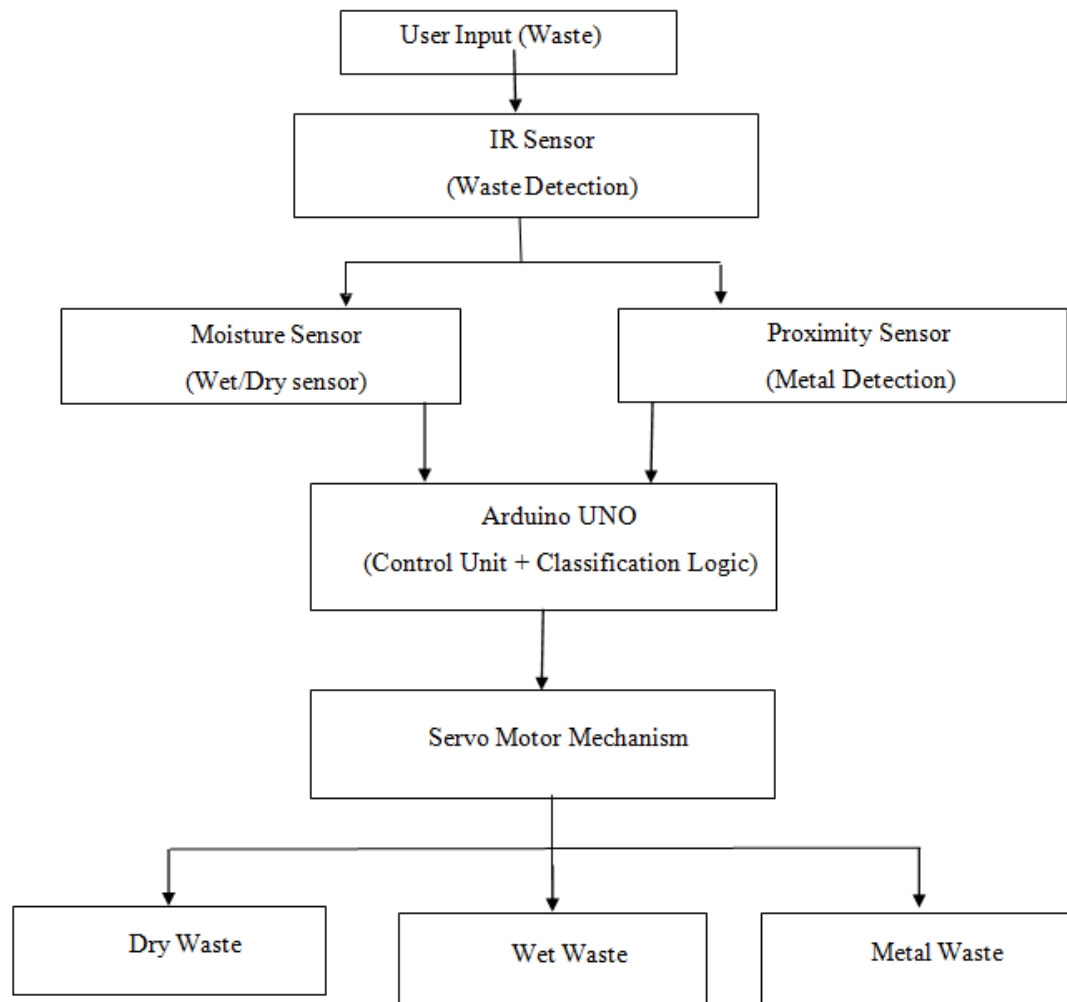


Figure1: Block Diagram of Proposed System

The system begins with the sensor setup, where the IR sensor detects the presence of waste material placed in the bin. Once detected, the moisture sensor determines whether the waste is wet or dry, while the proximity sensor identifies if the material contains metal. These sensors work together to gather essential data about the type of waste being processed. The collected data is then transmitted to the Arduino UNO, which functions as the central control unit. The Arduino interprets the signals from the sensors, applies programmed classification logic, and decides the appropriate waste category based on the sensor readings.



After processing the input data, the system moves to the waste separation stage, where the servo motor mechanism plays a crucial role. Based on the Arduino's output signal, the servo motor rotates the flap toward the corresponding bin — directing the waste into either the wet, dry, or metal waste container. This automated movement ensures accurate sorting without the need for human intervention, reducing manual effort and enhancing hygiene. The integration of sensors and servo mechanisms not only improves efficiency but also enables real-time waste management. Such automation contributes to effective recycling and sustainable waste handling, especially in smart city environments. Overall, the methodology demonstrates a reliable, low-cost, and eco-friendly approach to waste management by combining sensor technology, Arduino-based control logic, and mechanical automation for intelligent waste classification and disposal.

IV. CONCLUSION

The proposed IoT-based solid waste management system will successfully demonstrate an automated approach to waste segregation using IR and moisture sensors integrated with an Arduino UNO. By identifying and classifying waste as wet, dry, and metal in real-time, the system will reduce dependence on manual segregation, thereby improving hygiene and efficiency. The servo-controlled mechanism will ensure proper disposal of waste into designated bins, making the process reliable and user-friendly. Overall, the system will highlight how IoT and automation can be effectively leveraged to address one of the most pressing urban challenges, while also leaving scope for future enhancements such as cloud monitoring, data logging, and classification of multiple waste categories.

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